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Participatory Selection of Local Ecotypes of Voandzou by Producers in a Controlled Environment in the Sudanian Zone of Chad

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ABSTRACT

The cultivation of voandzou (*Vigna subterranea L*) appears to be neglected ; it remains largely a traditional and family-based agriculture. Consequently, its productivity is low due to unknown technical itineraries and limited access to high-performing varieties by farmers. The objective of this study is to involve producers in evaluating the varietal characteristics of local ecotypes in a controlled environment. The plant material consists of twenty (20) local voandzou ecotypes selected across Chad's regions and pre-coded. The « mother trial » experiment is conducted following a Fisher block experimental design with three repetitions. Participatory varietal selection (PVS) is carried out with about forty farmers. Two groups are formed for this operation : a group of fourteen (14) women and a group of fourteen (14) men. Each group received six different-colored cards to assess the best ecotypes and identify the mediocre ones. The Ts_Vou_81 variety was the most appreciated at 28.57% by men for its varietal characteristics. The second most appreciated variety by men is TS_vou_79 at 23.80%. The third is TS_vou_104 at 19.04%. Among women, Ts_vou_166 was the most appreciated at 19.04%. Varieties TS_vou_104, Ts_vou_2, and Ts_vou_79 follow, each appreciated at 14.28% by women. The varieties Ts_vou_81 and TS_vou_79 were equally appreciated at 19.51% by both men and women. The third most appreciated at 17.07% by both

genders is TS_vou_104. The ecotypes that meet the satisfaction criteria of the participating breeders will be made available for dissemination.

Keywords : *Vigna subterranea L*, participatory selection, local ecotypes, crop valorization, Chad.

INTRODUCTION

Chad is one of the largest countries in Africa, located at the heart of the continent. Its population is concentrated mainly in the south, with agriculture being the primary activity. Agriculture is a key pillar of the economy, contributing around 23% to the GDP (Five-Year Agricultural Development Plan, 2013), and employs 80% of the rural active population. The arable land is estimated at over 39 million hectares, representing 30.37% of Chad's surface area. Despite these potentials, food insecurity has been increasing in recent years, mainly driven by climate change and poor agricultural practices. Chadian agriculture is mostly rain-fed and based on family farms (Nadjiam and Goalbaye, 2014). Farmers face declining yields and long crop cycles that do not align with the rainy season. In the provinces of Moyen-Chari and Mandoul, voandzou production decreased from 11,468.2 tons in 2018 to 10,804 tons in 2022 (ANADER, 2024). Although voandzou adapts well to harsh climatic conditions, its cultivation remains traditional and family-based. Its productivity is low due to unknown technical practices and limited access to high-performing varieties (Goalbaye et al., 2023). It should be valorized, intensified, and popularized because of its contribution to food security and soil fertility maintenance. Therefore, valorization of underexploited crops such as voandzou is crucial for food security in Chad. Despite research efforts, challenges persist, notably drought, which remains one of the most complex issues affecting agricultural production in the Sudanian zone of Chad (Goalbaye et al., 2014). Special attention should be given to voandzou cultivation amidst current climate changes. Several studies on voandzou have been conducted (Massawe et al., 2005 ; Mungate, 1997 ; Goalbaye et al., 2023). However, current research efforts remain insufficient, and drought continues to pose significant problems. Therefore, participatory selection of high-performing voandzou ecotypes becomes essential. The overall goal of this study is to improve voandzou productivity and farmers' income. Specifically, the study aims to involve farmers in evaluating the characteristics of voandzou ecotypes present in a controlled environment to gather their perspectives.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted in August 2024 at the University of Sarh (UDS), Doyaba site (09°08'18''89 N, 18°42'29''47 E, altitude : 360 m), in the Moyen Chari province. The climate is of the Sudanian type (average rainfall : 1100 mm/year ; temperature : 24–38°C). The soils are ferruginous, leached, reddish in color, with a uniform clay-sandy to clay texture, slightly acidic in surface and very acidic in depth (Naïtormbaïdé, 2012).

Material

The plant material consists of twenty (20) local voandzou ecotypes selected across Chad and pre-coded (Ts_vou_164, Ts_vou_180, Ts_vou_139, Ts_vou_166, Ts_vou_3, Ts_vou_141, Ts_vou_108, Ts_vou_165, Ts_vou_170, Ts_vou_29, Ts_vou_105, Ts_vou_81, Ts_vou_89, Ts_vou_104, Ts_vou_2, Ts_vou_152, Ts_vou_167, Ts_vou_100, Ts_vou_79, Ts_vou_55). The crop

management is relatively improved (plowing, weeding, without fertilizer or pesticide application).

Methods

The trial was conducted following a Fisher block experimental design with three repetitions (mother trial). The twenty ecotypes represent the treatments tested. The size of the elementary plot is 6 m x 3 m = 18 m^2 ; the size of each plot within a block is 18 m^2, with a total of 20 plots per block totaling 360 m^2. The alley between blocks is 1.5 m, and the alley between plots is 0.3 m. The total experimental area is 1080 m^2 (360 m^2 x 3). The experiment considers a single factor : the genetic potential (performance) of local ecotypes.

Cultivation Management

The plots were plowed to a depth of approximately 15–20 cm, then harrowed to prepare seedbeds. Sowing was performed after at least 20 mm of rainfall. Sowing involved two seeds per hole, planted about 5 cm deep, with a spacing of 30 cm x 30 cm. The first weeding was done 10 days after emergence (JAL), followed by a second at 15 days after the first, and a third at 18 days after the second.

Phenological Observations

Phenological observations focused on: 50% emergence, 50% flowering, and crop cycle duration.

Participatory Variety Selection (PVS)

Participatory Variety Selection (PVS) was carried out 85 days after sowing (DAS) with around forty producers and researchers from different voandzou production areas. This collaborative research practice brings together farmers and researchers with the goal of innovating in agronomic research (Faure et al., 2018), particularly in varietal improvement (Ashby et al., 1995 ; Begna, 2022). Two groups were formed for this field-based participatory selection : one group of fourteen (14) women and another of fourteen (14) men. Each woman received six cards (three yellow and three green), making a total of eighty-four (84) cards—forty-two (42) for selecting the best ecotypes and forty-two (42) for identifying ecotypes with poor varietal characteristics. Each man received the same number of cards—three red and three blue—also totaling eighty-four (84), divided similarly between appreciation and non-appreciation. Afterward, both groups combined their evaluations, resulting in a total of 168 cards : 84 for selecting the best ecotypes and 84 for identifying those with undesirable traits. This process is referred to as the « varietal voting operation ». Before the selection, ten (10) voandzou plants were uprooted and placed in front of each elementary plot along with their identification plates. Replication 1 was used for the women's group. Each woman walked by the plots, evaluating the ecotypes ; if she appreciated one, she placed a green card in front of that plot, with three green cards ranked by preference. Yellow cards were used for the least appreciated ecotypes. Replication 2 was used for the men's group. Blue cards were used for the most appreciated ecotypes, and red cards for the least appreciated ones. Replication 3 involved both groups together (28 participants), each providing 6 cards (28 x 6 = 168 cards) using the same procedure. After this « varietal voting session, » the cards were collected and counted to determine the results.

Observed or Recorded Parameters

The agronomic parameters observed and recordé included: Number of leaves, aerial biomass, and seeds.

Statistical Data Analysis

The data collected is entered into an Excel 2010 spreadsheet and submitted to a descriptive statistical analysis in terms of percentages.

RESULTS AND DISCUSSION

Results

Positive Voting of Local Voandzou Ecotypes by Men

The results of the male producers' varietal preference analysis are shown in Figure 1. The variety TS_vou_81 received twelve (12) positive votes (cards), followed by TS_vou_79, TS_vou_104, and TS_vou_141 with ten (10), eight (8), and six (6) votes respectively. TS_vou_167 received four (4) points, and TS_vou_29 received two (2) points. The other ecotypes received no positive votes (zero points). TS_vou_81 was the most appreciated variety (28.57%) among men for its varietal traits. It showed good vegetative development, had floury seeds, and resistance to pests. TS_vou_79 was the second most appreciated variety (23.80%) for its agronomic traits, with persistent leaves even at the end of the rainy season and large seeds. The third most appreciated (19.04%) was TS_vou_104, which had seeds resistant to rot and produced good yields even under poor rainfall or delayed sowing conditions.

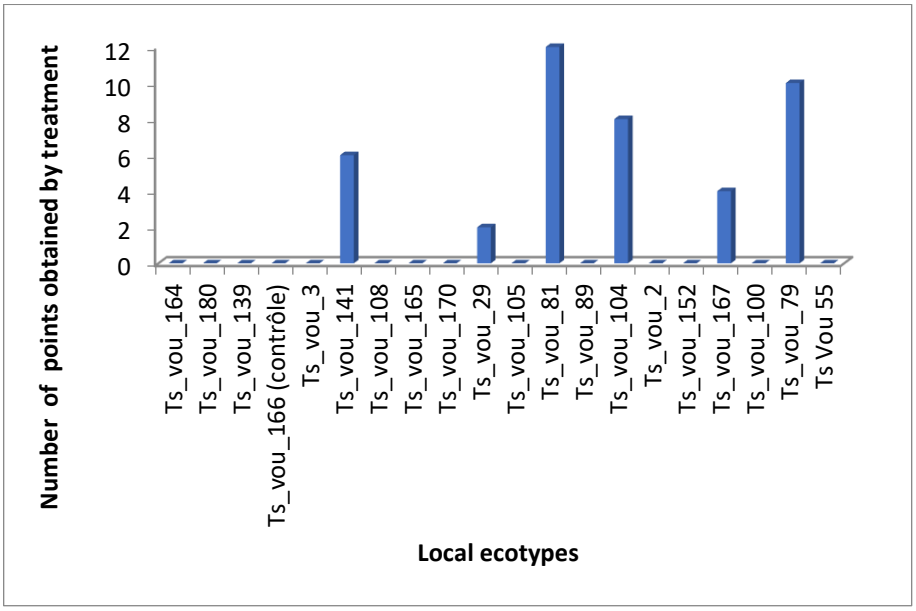

Figure 1: positive vote for local ecotypes of voandzou by men

Negative Voting of Local Voandzou Ecotypes by Men

The results of the male producers' analysis of least preferred varieties are shown in Figure 2. TS_vou_108 received fourteen (14) negative votes, followed by TS_vou_55 and TS_vou_29 with eight (8) and six (6) negative votes, respectively. TS_vou_165 and TS_vou_152 each received four (4) negative votes. TS_vou_170, TS_vou_3, and TS_vou_164 received two (2) votes each. The more a variety received negative votes, the more it was rejected by the producers.

TS_vou_108 was the least appreciated variety (33.33%) due to small, less floury seeds that were hard to harvest. The second least appreciated (19.04%) was TS_vou_55, which had a long cycle and low yield. TS_vou_29 came third (14.28%), with poor storage, small seeds, and a long cycle.

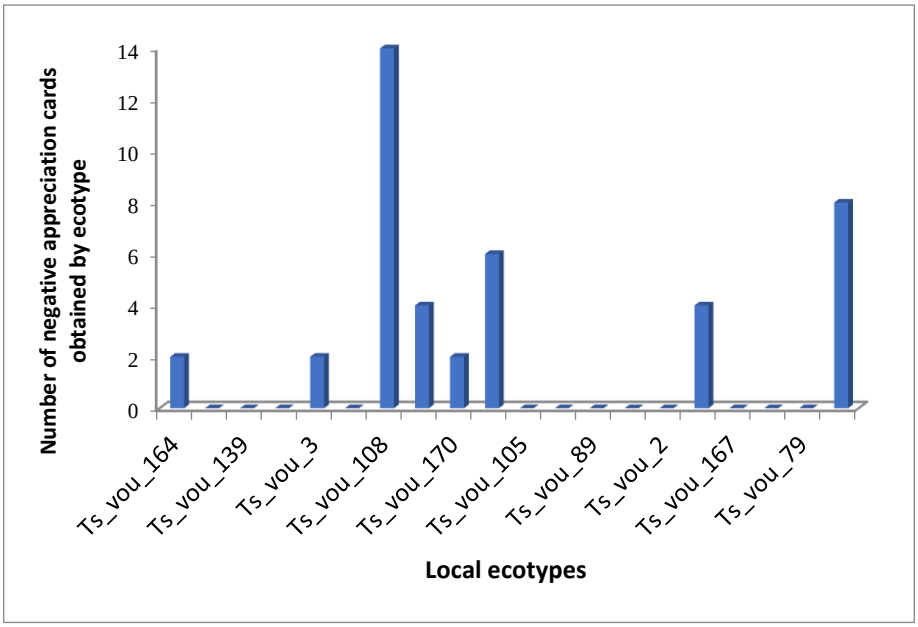

Figure 2: negative vote for local ecotypes of voandzou by men

Positive Voting of Local Voandzou Ecotypes by Women

The results of female producers' preference analysis are shown in Figure 3. TS_vou_166 received eight (8) positive votes, followed by TS_vou_104, TS_vou_2, and TS_vou_79, each with six (6) votes.

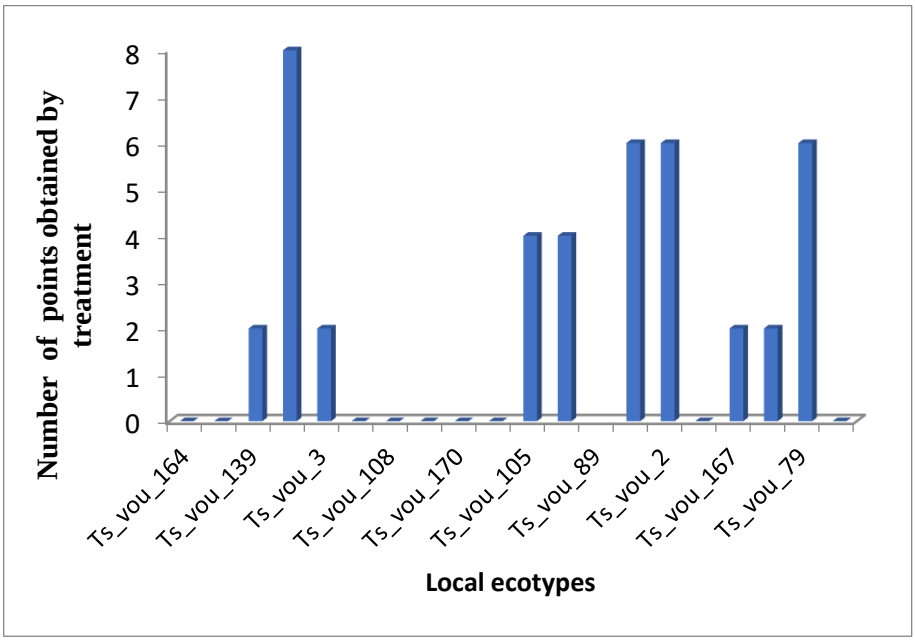

Figure 3: positive vote for local ecotypes of voandzou by women

TS_vou_105 and TS_vou_81 received four (4) votes each, while TS_vou_139, TS_vou_3, TS_vou_167, and TS_vou_100 each received two (2) votes. The other varieties received no points. TS_vou_166 was the most appreciated variety (19.04%) among women for its varietal traits. It had a good seed coat and yield and was resistant to pests. TS_vou_104, TS_vou_2, and TS_vou_79 were second most appreciated (14.28%). TS_vou_104 had seeds resistant to rot and insect attacks, and they were easy to grind. TS_vou_79 had good taste and large seeds. TS_vou_2 had floury seeds and was pest-resistant.

Negative Voting of Local Voandzou Ecotypes by Women

The results of the analysis of least preferred varieties by women are shown in Figure 4. TS_vou_164 and TS_vou_180 each received eight (8) negative votes, followed by TS_vou_166 and TS_vou_165 with six (6) votes each. TS_vou_141 received four (4) votes. TS_vou_3, TS_vou_108, TS_vou_89, TS_vou_152, and TS_vou_55 each received two (2) negative votes. Other varieties received none. TS_vou_164 and TS_vou_180 were the most rejected varieties (19.04%) due to fast wilting, small seeds, and low yields. TS_vou_165 and TS_vou_166 were the second least appreciated (14.28%). TS_vou_165 had a black seed coat, which turned the paste black during cooking. TS_vou_166 had small seeds, low yield, and a long cycle. TS_vou_55 had a long cycle and low yield.

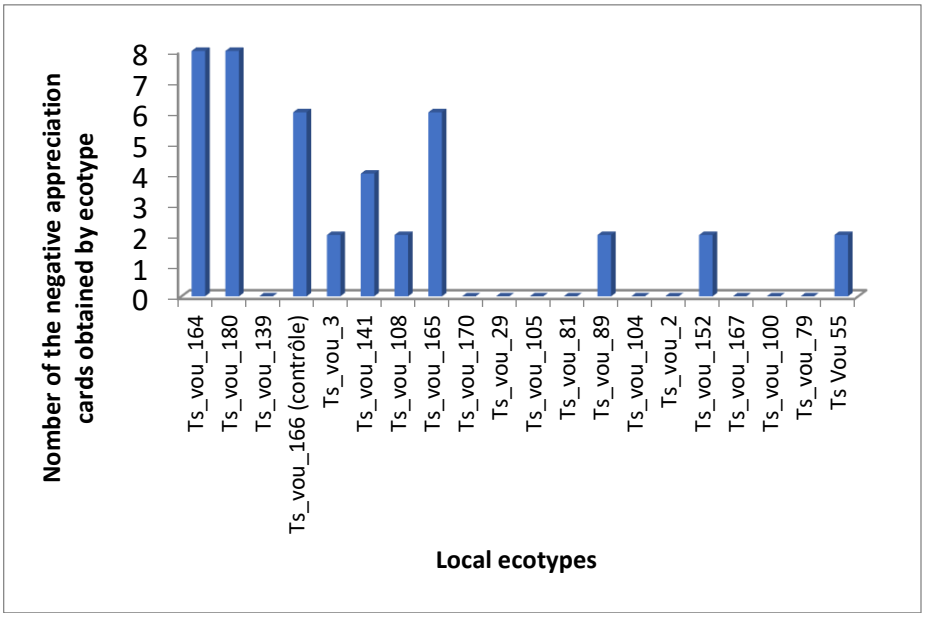

Figure 4 : negative vote for local ecotypes of voandzou by women

Positive Voting of Local Voandzou Ecotypes by Both Men and Women

The results of the combined varietal preference analysis by male and female producers are shown in Figure 5. The varieties TS_vou_81 and TS_vou_79 each received sixteen (16) positive votes, followed by TS_vou_104 with fourteen (14) votes. TS_vou_166 scored eight (8) points, and TS_vou_141, TS_vou_2, and TS_vou_167 each scored six (6) points. TS_vou_105 received four (4) votes, and TS_vou_100, TS_vou_29, TS_vou_3, and TS_vou_139 received two (2) votes each. The other ecotypes received no positive appreciation cards. TS_vou_81 and TS_vou_79 were the top-ranked varieties (19.51%) appreciated by both men and women for their varietal characteristics. TS_vou_81 showed strong vegetative development, had floury seeds, and was

pest-resistant. TS_vou_79 had persistent foliage at the end of the rainy season and large seeds. The third most appreciated variety (17.07%) was TS_vou_104, which had rot-resistant seeds and performed well even under poor rainfall or delayed planting.

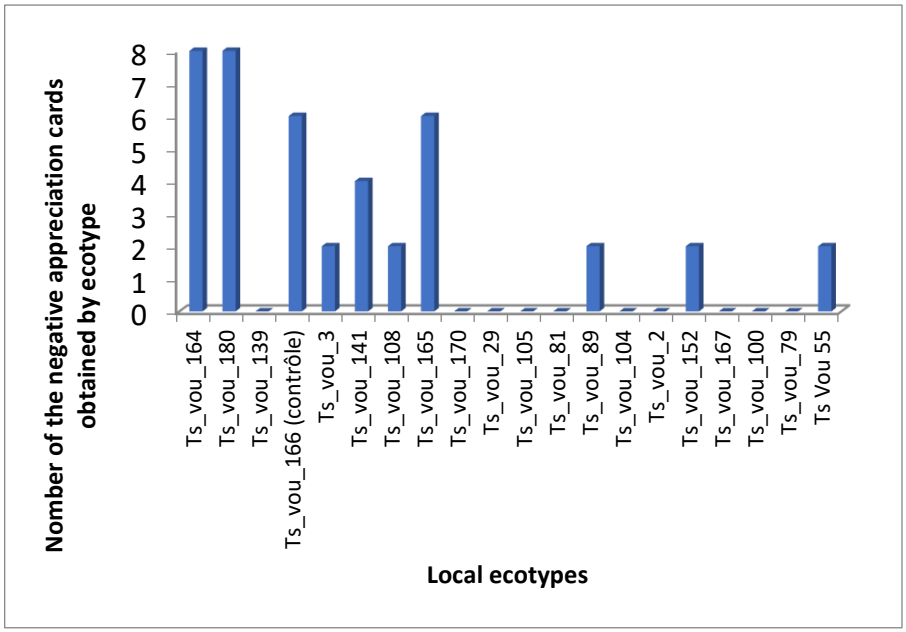

Figure 5: positive vote for local ecotypes of voandzou by men and women

Negative Voting of Local Voandzou Ecotypes by Both Men and Women

The results of the combined analysis of least preferred varieties by both men and women are shown in Figure 6.

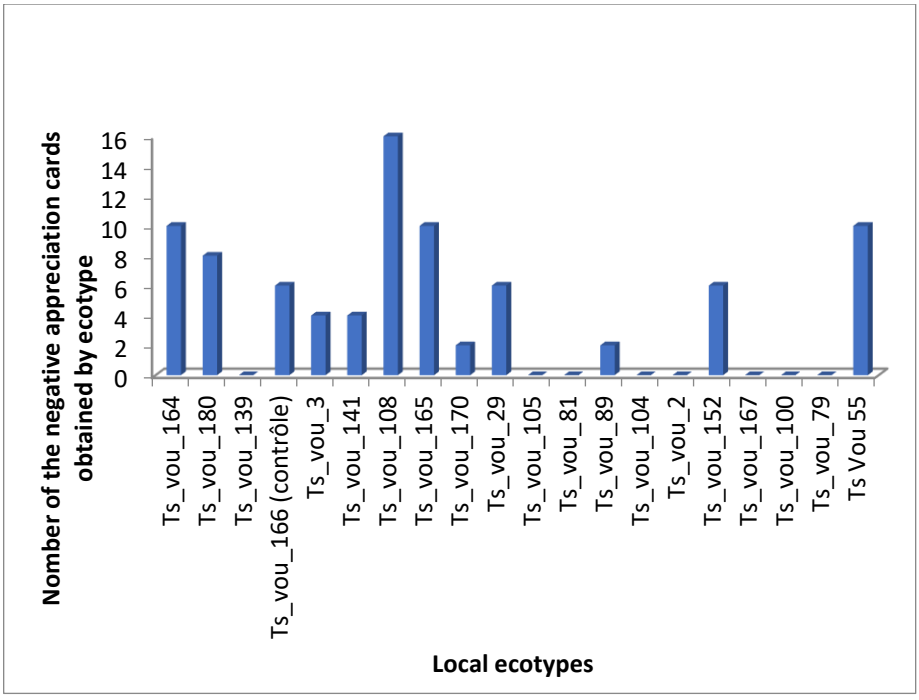

Figure 6 : positive vote for local ecotypes of voandzou by men and women

TS_vou_108 received sixteen (16) negative votes, followed by TS_vou_164, TS_vou_165, and TS_vou_55 with ten (10) negative votes each. TS_vou_180 scored eight (8) negative votes. TS_vou_166, TS_vou_29, and TS_vou_152 each received six (6) negative votes. TS_vou_3 and TS_vou_141 received four (4) votes each, and TS_vou_170 and TS_vou_89 scored two (2) negative votes. The other varieties received no negative votes. TS_vou_108 was the most rejected variety (19.04%) by both men and women due to its small, less floury seeds and harvesting difficulties. TS_vou_164, TS_vou_165, and TS_vou_55 followed (11.90%) as the least appreciated. TS_vou_164 wilted quickly, had small seeds, and low yield. TS_vou_165 had a black seed coat that turned the paste black during cooking. TS_vou_55 had a long cycle and low yield.

Discussion

The involvement of producers in Participatory Variety Selection (PVS) strengthens socio-economic ties by structuring farmer seed organizations (Dawson et al., 2008 ; Demeulenaere et al., 2017a; Autfray et al., 2022). Farmer participation in agricultural research has existed for decades (Pretty, 1995). The preferential analysis of voandzou ecotypes by producers led to the selection of four (4) top varieties (TS_vou_81, TS_vou_79, TS_vou_104, TS_vou_166) out of the twenty (20) ecotypes tested in the agronomic "mother trials." PVS supports farmer autonomy and preserves biodiversity (ADDEAR 42, 2016). Selection was based on agronomic traits that meet producers' food security goals. Additionally, the selected varieties matched the expectations of both farmers and researchers through participatory evaluations (Fanilo, 2023). However, six (6) ecotypes (TS_vou_108, TS_vou_55, TS_vou_29, TS_vou_180, TS_vou_164, TS_vou_165) were not appreciated. This phenotype-based participatory selection has limitations. Prior studies have highlighted that varieties selected by geneticists in station conditions often outperform those selected through participatory methods (Courtois et al., 2001 ; Ceccarelli et al., 2007). Thus, the ecotypes currently selected or rejected may eventually be selected again if improved through geneticist-led varietal enhancement.

CONCLUSION

The objective of this study was to select the best local ecotypes of voandzou through producer participation. Among the twenty (20) ecotypes tested in the "mother trial," the top variety appreciated by men for its varietal traits was TS_vou_81, followed by TS_vou_79 and TS_vou_104. For women, TS_vou_166 was the most appreciated, followed by TS_vou_79 and TS_vou_104. TS_vou_81 and TS_vou_79 were the top varieties appreciated by both men and women. On the other hand, TS_vou_108 was the least appreciated by men, followed by TS_vou-55 and TS_vou_29. For women, TS_vou_164 was the least appreciated, followed by TS_vou_180 and TS_vou_165. Overall, TS_vou_108 was the most rejected variety (19.04%) by both genders. TS_vou_164, TS_vou_165, and TS_vou_55 were among the least appreciated varieties by both men and women, as they did not meet producer expectations. Therefore, future studies incorporating molecular marker-assisted selection are recommended to confirm these results and help identify stable, high-performing varieties suitable for the study area.

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